SERMA
PRODUCTIVITY ENGINEERING

Datasheet

PE3011

Table of Content

1 Revision History

Version	Date	Changes	Page
Initial Version 1.0	07/2010		
Version 1.1	10/2010	Added not [1)]	10
Version 1.2	10/2010	CP/CN Y correction	5, 6
Version 1.3	03/2012	Figure 2 / Table 1 updated	5, 6

2 Introduction

PE3011 is a HF RFID Tag IC with an integrated data monitoring system.

Main features are:

- Passive transponder chip according to ISO15693
- Temperature measurement and storage including a time stamp in the integrated non-volatile EEPROM
- Energy for communication provided through the RF field, energy for the data monitoring provided through a battery
- power management for the different power domains
- 8kBit EEPROM can be written and read through the RF field and the data monitor
- Fully integrated system without any need for external devices (antenna and battery only)
- Extra signal output for “out-of-limits” temperature/external sensor detection
- Continuous battery control and automatic shut down
- Extended battery supply voltage range for single or dual cell supply
- Password protection for monitored data
- Data monitor for internal and/or external sensor or only for user defined data
- Implementation of external analogue sensors (X,Y) over a differential interface
  - normal measurement function for capacitive sensors
  - Interrupt function with user defined variables and sampling
- Additional functionality possible through SPI (µC, external Sensors)

3 External References

- ISO 15693-2
- ISO 15693-3

4 PE3011 Overview

The PE3011 is an integrated circuit for tracking and controlling in logistic environments. It monitors the chip temperature, values from external capacitive analogue sensors and related time data everywhere during transport or storage. While not in an RFID reader field and so not being supplied through the reader the system draws the required energy from the battery. While in a HF reader field the system supplied by the reader's field energy and communicates to the reader based on the standard protocol. Besides standard ISO15693 communication additional ISO15693 functionality is implemented to read out memory data. The integrated SPI allows for communication with other external devices like a micro controller that can provide additional sensor functionality e.g. for digital sensors.
The IC contains the following main functional blocks:

- RFID Frontend for extraction of field energy and bidirectional communication
- Real Time Clock to provide an accurate clock signal of 8.738 kHz
- Internal temperature sensor and ADC for external capacitive sensors
- Digital controllers to manage all internal mechanisms, reader communication and access to the integrated 8kBit EEPROM
- SPI for external communication
- Power manager to control and switch between the different power domains within the IC

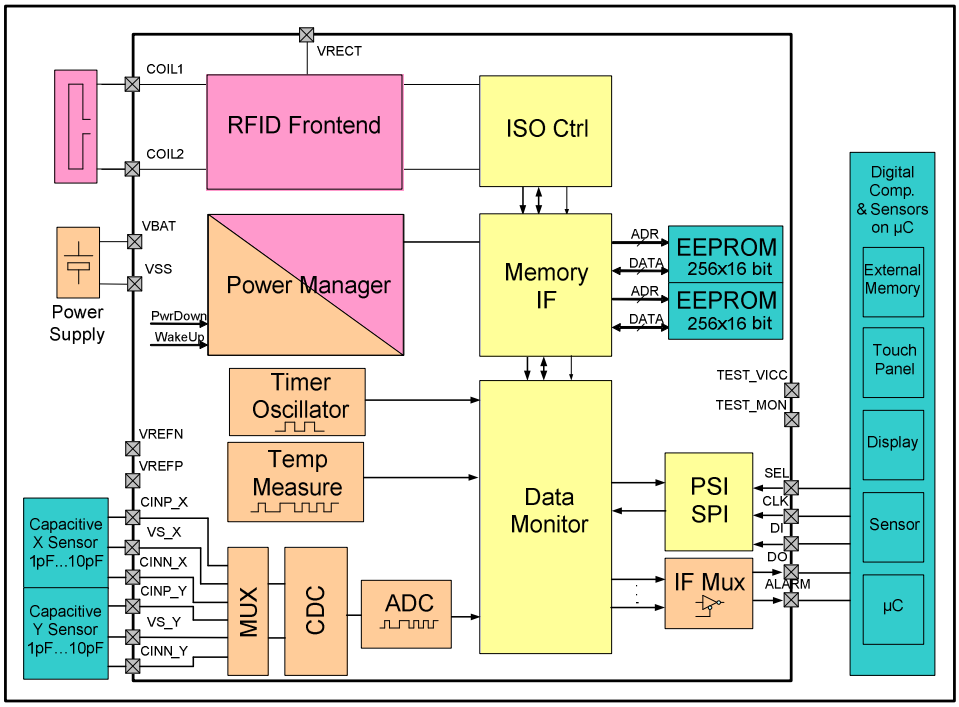

Figure 1 – PE3011 block diagram

5 Typical Application

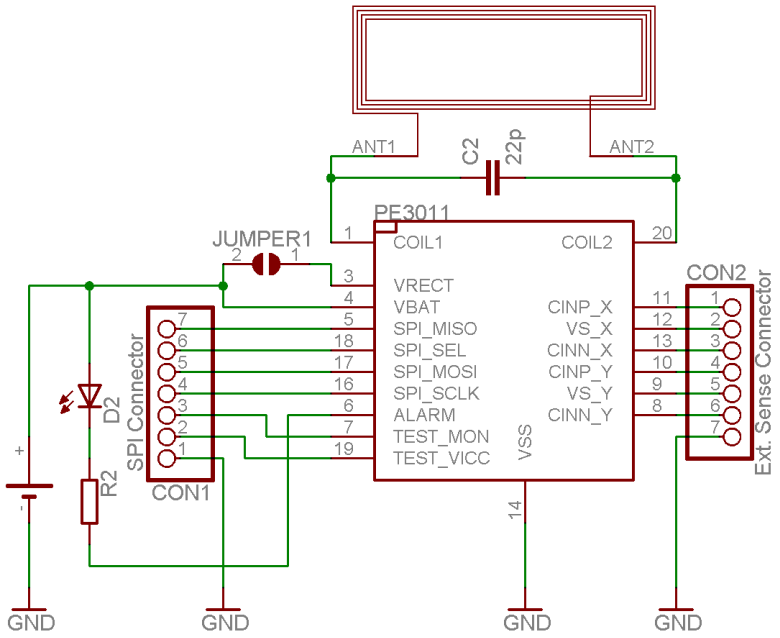

Figure 2 – Schematic of a typical application circuit

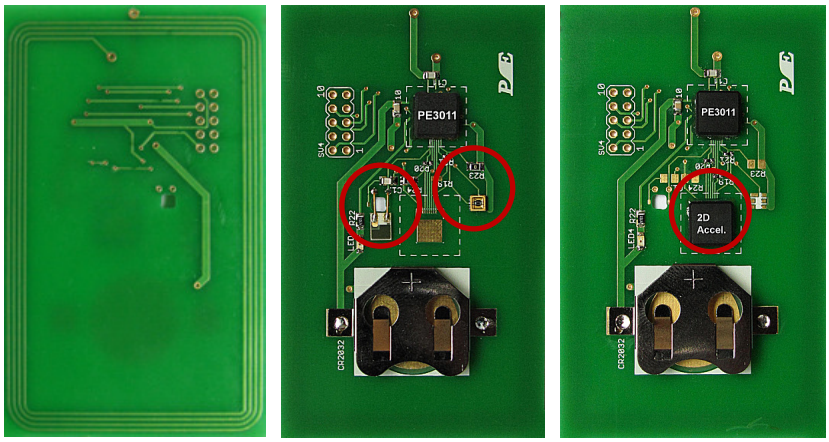

Figure 3 – Evaluation boards; back side with antenna coil (left), front side with moisture/pressure sensor (middle) and front side with 2D acceleration sensor

6 Pin Assignment / Package

The standard PE3011 comes in an TSSOP20 package. For high volume production the chip is also available as bare die.

Table 1 – Pin assignment

TSSOP20 Pin No.	Pin Name	I/O	Function
1	COIL1	analogue	RFID-Antenna
2	-	N.C.	Not connected
3	VRECT	power	RFID rectifier voltage
4	VBAT	power	Battery (+)
5	SPI_MISO	output	Send Data-Signal SPI
6	ALARM	output (OD)	Alarmport switched to ground, External Sense Mode Wakeup (Analogmux in test mode)
7	TEST_MON	input (PD)	Switchable as monitor
8	CINN_Y	analogue	Port 1 differential capacitive Y sensor
9	VS_Y	analogue	Middle port differential capacitive Y sensor
10	CINP_Y	analogue	Port 2 differential capacitive Y sensor
11	CINP_X	analogue	Port 1 differential capacitive X sensor
12	VS_X	analogue	Middle port differential capacitive X sensor
13	CINN_X	analogue	Port 2 differential capacitive X sensor
14	VSS	power	Battery (-)
15	-	N.C.	Not connected
16	SPI_SCLK	input (PD)	Clocksignal SPI
17	SPI_MOSI	input (PD)	Receiving Data-Signal SPI
18	SPI_SEL	input (PD)	Select-Signal SPI
19	TEST_VICC	input (PD)	Switching of test for VICC
20	COIL2	analogue	RFID-Antenna

PU = Pull Up, PD = Pull Down, OD = Open Drain

6.1 TSSOP20 Package Dimensions

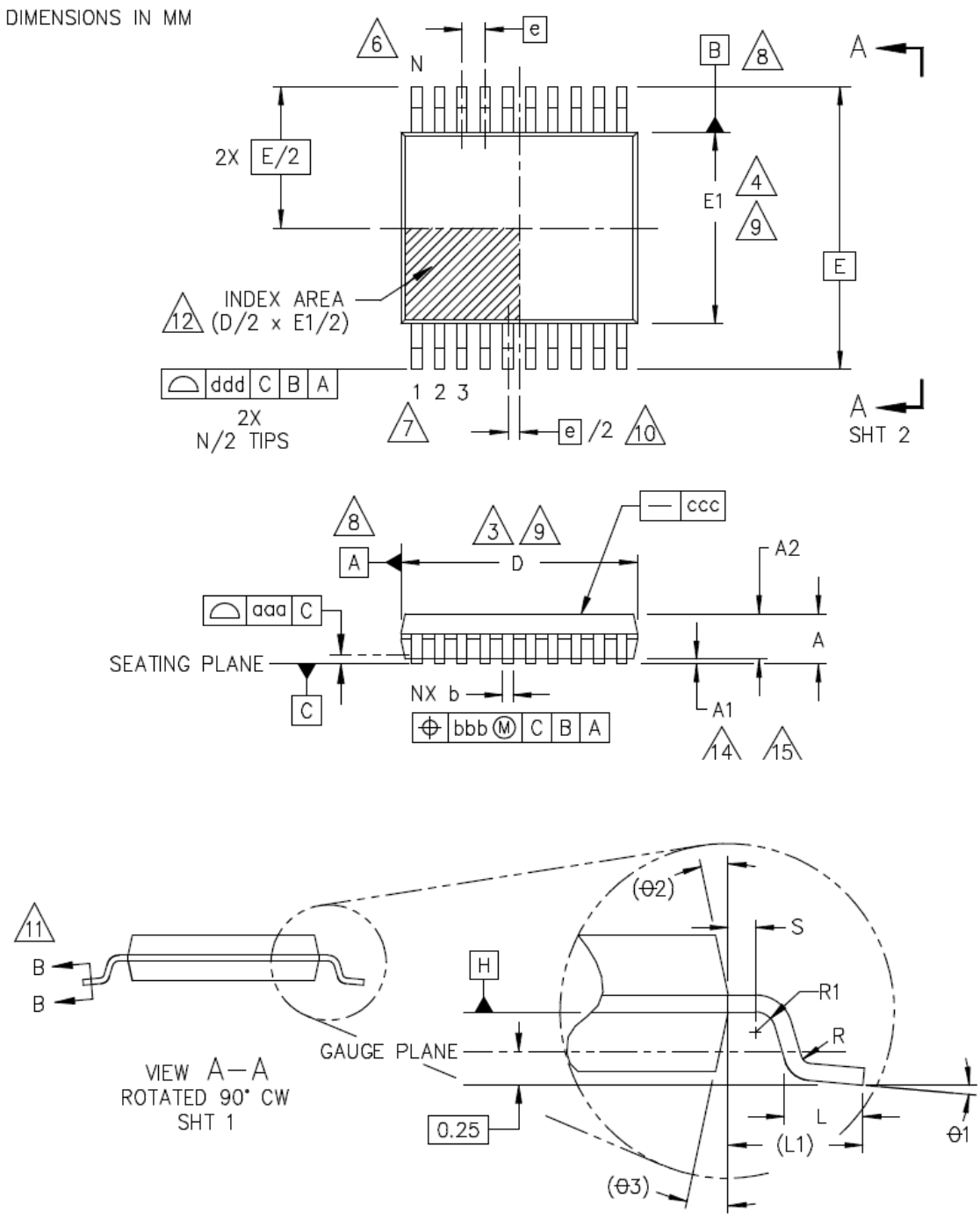

Figure 4 – TSSOP20 package dimensions

Table 2 – TSSOP20 package dimensions

SYMBOL	COMMON DIMENSIONS (Millimeters)		
	MIN	NOM	MAX
A	-	-	1,20
A1	0.05	-	0.15
A2	0.80	1.00	1.00
D	6.40	6.50	6.60
N		16	
b	0.19	-	0.30
b1	0.19	0.22	0.25
c	0.09	-	0.20
c1	0.09	-	0.16
E		6.40 BSC	
E1	4.30	4.40	4.50
e		0.65 BSC	
L	0.45	0.60	0.75
L1		1.00 REF	
R	0.09	-	-
R1	0.09	-	-
S	0.20	-	-
Θ1	0°	-	8°
Θ2		12 REF	
Θ3		12 REF	
SYMBOL	**TOLERANCES OF FORM AND POSITION**		
aaa		0.10	
bbb		0.10	
ccc		0.05	
ddd		0.20	
REF		11-360	
ISSUE		A	

7 Electrical Parameters

7.1 Absolute Maximum Ratings

Table 3 – Absolute maximum ratings

Parameter	Symbol	Min	Typ	Max	Unit
Junction-Temperature	T_{chip}	-40		120	℃
Input voltage	V_{in}	-0.3		V_{bat}+0.7	V
Output voltage	V_{out}	-0.3		V_{bat}+0.7	V
Antenna voltage	V_{ant}	-6.0		6.0	V
Battery voltage	V_{bat}	-0.3		3.6	V
Operating voltage	V_{dd}	-0.3		6.0	V

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

7.2 Typical Operating Conditions

Table 4 – Typical operating conditions

Parameter	Symbol	Min	Typ	Max	Unit	Comment
Operating temperature	T_{amb}	-40	27	85	°C	
RF field frequency	f_{rf}		13,56		MHz	
Magnetic field strength		150		5000	mA/m	passive tag [1)]
Battery voltage data monitor	V_{bat}	2.4	3.3	3.6	V	
Power consumption data monitor (without ext. sensor)	P_{mon}		5		µW	average for log interval
EEPROM block size			256x32		Bit	
EEPROM write cycles		100.000				@ 25°C
EEPROM write cycles		10.000				@ 125°C
EEPROM data retention		10			years	@ 85°C
Accuracy data monitor		-0.80 -1.6		0.80 1.6	°C	-20°C to 30°C [2)] 30°C to 50°C [2)]
Measurement resolution		0.3	0.4	0.5	°C	8 bit value
Accuracy time		-3		+3	%	
AlarmPort current	I_{drain}		5		mA	open drain output

[1)] The communication range might not fully fit the specified range. The reading distance can be increased by connecting a external capacitor of 3.3nF at VRECT to ground to buffer the internal digital supply voltage.

8 Functional Description

8.1 General

The PE3011 is an ISO15693 Transponder chip, implementing basic ISO15693 functionality. Additionally it also contains a temperature measurement unit, an ADC for external capacitive sensors and a real time clock.

Since the primary application is meant to be in the absence of a reader field the data monitor (temp + capacitive + time) can be supplied through two pins by an external battery with a wide voltage range. RFID communication is passive. This means even when the battery is empty or not connected the communication can be conducted and stored data can be read as well as written into not protected addresses.

Memory access is granted through the HF reader controller as well as through the data monitoring controller. Both blocks have the same priority. No started memory access will be interrupted by a request for another access. The started access will be finished first before the new access request will be acknowledged.

For configuration and data storage the ISO15693 and PE GmbH specified memory blocks where extended. Monitoring configuration is controlled by the MONREG bank. Through this UID bank, user data and monitoring function/setup can be protected separately for read and write access. Measured temperature data in the MONDAT bank cannot be written through the RFID field.

An external microcontroller can be connected for communication through the SPI interface. External digital sensors, displays, buttons and other devices can interface to the IC field this way and get all kind of access to data being stored in the RFID chip memory. All memory address space can be accessed this way.

8.2 Memory Concept

Control of the data monitor is being conducted through the MONREG bank. It manages the configuration. Measured data are being stored in the MONDAT bank. The variable MonDataEnd, in the monitor configuration within the MONREG bank, defines the border between MONDAT and USER bank. USER bank can be used to store user specific information.

8.3 Security Concept

All access mechanisms can be used as specified in the IS15693 standard. For this reason the data to be stored are separated like this:

Table 5 – Security concept

EPROM Bank	Data	Access Rights
UID	FLAGS, DSFID, VICCMSInfo, ICREF, AFI, UID, LOCK	read only, writeable with ISO commands
	TempScaling	Scaling factor and offset for measurements
	MonCycle	read only
MONREG	Monitor configuration	read & write, when MONREG bank is not locked (write stops the monitor and resets Status / LogCount)
MONDAT	Interrupt data	read only
	Temp data	read only
USER	User data	read & write, when USER bank is not locked

9 Memory Organization

9.1 UID Bank

The UID bank is organized to set flags for ISO15693 protocol and contains information about the manufacturer of the tag and the tag version.

Table 6 – UID bank

UID Bank	Bit 31 … 0
00h	InfoFlag, DSFID, VICCMSInfo
01h	RFU,T1OVH,ICREF, AFI
02h	UID[63:32]
03h	UID[31:0]
04h	LOCK[31:0]
…	LOCK[223:32]
0Bh	LOCK[255:224]
0Ch…0Dh	RFU
0Eh	TempScaling
0Fh	MonCycle

One can not write theses commands through the HF interface, except by using special commands (ISO conform).

T1OVH
Overhead value to calibrate the T1 time for VICC to Tag communication.

TempScaling
Data for Scaling the temperature measurement with Slope and Offset.

MonCycle
The operating cycle counter is incremented with every sensor measurement (temperature and external analog sensor. It will never be erased. At the end of the counter space (FFFFFFFFh) the data will remain fixed at the value FFFFFFFFh.

UID (offer)

Table 7 – Chip UID

Header	IC MFG code	Product	Revision	Wafer ID	Chip X	Chip Y
63 … 56	55 … 48	47 … 44	43 … 40	39 … 16	15 … 8	7 … 0
E0h	3Eh	0h	0h	00 00 00h	00h	00h
8 bit	8 bit	4 bit	4 bit	24 bit	8 bit	8 bit

Sections of the UID have the following meaning:

- Header: E0, to mark ISO15693
- IC MFG code: definition by user “PE GmbH”
- Product: 0 for HF Datamonitor, can be arranged by user
- Revision: chip revision (for potential chip iterations)
- Wafer ID: consecutive number for every wafer
- Chip X: X-coordinate of chips on wafer
- Chip Y: Y-coordinate of chips on wafer

9.2 MONREG Bank

The MONREG bank contains all necessary information about the data monitoring configuration for temperature data and external sensor data.

Table 8 – MONREG bank

MONREG Bank	Bit 31..24	Bit 23..16	Bit 15..8	Bit 7..0
10h	RFU	IntAddrCnt	Statusflags	MonIndicator
11h	0000 CLK1MTRIM	IntSample	000 000 DEY DEX	0 MWE IM AY AX TM
12h	TempLimit		RTCTrim (CLKTTrim, CLKFTrim)	
13h	00 TMSTrimOffs		TMSTrimOSC	
14h	IntDataArea	AlarmNbr	SPI Sense 000 MW	MonDataEnd
15h	TimePreset			IntervalLength
16h	IntDataXH		IntDataXL	
17h	IntDataYH		IntDataYL	
18h	CoeffGainX		CoeffOffsX	
19h	CoeffGainY		CoeffOffsY	
1Ah	CPENY CPY	CNENY CNY	CPENX CPX	CNENX CNX
1Bh	Calib_ConstY		Calib_ConstX	

IntAddrCnt (8 Bit, 23:16) 10h
Number of written interrupt addresses in interrupt mode of external analog sensors.

Statusflags (8 Bit, 15:8) 10h
Bit 7: Initialisation, Monitor is started
Bit 6: Monitoring Active
Bit 5: Memory Overflow
Bit 4: Watchdogtimer Error
Bit 3: Battery Error
Bit 2: AlarmPort is settled
Bit 1: Outband Mode
Bit 0: Interrupt ext. sensor is triggered

MonIndicator (8 Bit, 7:0) 10h
The MonIndicator shows, how many measurements were written into the EEPROM. It will incremented after every write cycle. Statusflags and MonIndicator are implemented as dynamic registers and will be deleted at Power On Reset. This value shows an address for storage of temperature data.

RFU 10h
Reserved for future use.

CLK1MTRIM (4 Bit, 27:24) 11h
Value to trim 1MHz oscillator for external sense ADC clock. *This value is being set in IC production.*

IntSample (8 Bit, 23:16) 11h
Timing definition (Data * 8kHzOscillator) to sample interrupt data interval in interrupt mode. Typically defined at 10ms.

DEY (1 Bit, 9) 11h
DIFF_ENY - this Flag enables a differential ('1') or single ended ('0') sensor capacitor.

DEX (1 Bit, 8) 11h
DIFF_ENX - this Flag enables a differential ('1') or single ended ('0') sensor capacitor.

MWE (3 Bit, 6:4) 11h
MWE defines the number of the average calculation exponent for the external sensors. The average is calculated by 2^MWE measurements. The result will be stored as averaged sensor value.

IM (1 Bit, 3) 11h
Interrupt mode for external sensors - this bit defines how to handle the external sensors in Sensedatamonitor. When "active" external sensor data with interrupt parameter will be stored when an interrupt occurs. When not "active" all sensor data will be stored.

AY (1 Bit, 2) 11h
Flag for external sensor Y. If an external sensor is connected to Y-Port this flag is set to "active". In an application with just one external sensor the X-Port has to be used.

AX (1 Bit, 1) 11h
Flag for external sensor X. If an external sensor is connected to X-Port this flag is set to "active". In an application with just one external sensor the X-Port has to be used.

TM (1 Bit, 0) 11h
Flag for internal temperature sensor. If a temperature measurement shall take place this flag will switch to the "active" state. If there is no connection to an external sensor this flag is automatically "active".

TempLimit (16 Bit, 31:16) 12h
These two bytes are for temperature limits (TempHiLimit, TempLowLimit). They are being used in Outband Mode only. At a temperature over- or underride averaged temperature data will be stored in the EEPROM. No data will be stored when the measured values are within the limits.

RTCTrim (16 Bit, 15:0) 12h
Value to trim the 8kHz oscillator of Sensedatamonitor clock. *This value is being set in IC production.*

TMSTrimOffs (14 Bit, 29:16) 13h
Value of offset counter for temperature measurement. *This value is being set in IC production.*

TMSTrimOSC (16 Bit) 13h
Calibration to trim temperature measurement oscillator frequency. *These values will be set at wafer test.* This scaling provides all factors to calculate real temperature values from whole-numbered temperature values. The temperature can be calculated according to this formula:

$$T\,[°C] = \frac{Slope}{100} \cdot Value - Offset$$

This value is being set in IC production.

IntDataArea (8 Bit, 31:24) 14h
Number of Interrupt Adresses for external Sensors in MONDAT beginning from 1Ch to 1Ch+IntDataArea-1. If IntDataArea is 00h then the Interruptflag INT_MODE will be ignored.

AlarmNbr (8 Bit, 23:16) 14h
If the MonIndicator (number of logged data blocks) is larger than AlarmNbr, the alarm port will be switched to VSS. In combination with the OUTBAND MODE the alarm port can be used for signaling when the tag was below or above a certain programmed temperature value.
The related AlarmPort will go back to its original state (“high Z“) after the monitor has been turned off, battery low-signal has been detected or the memory is full, even though the information is still in AlarmNbr. For this reason it is recommended to use chemical visual displays that change the colour only once when power is applied. The use of an external or partially external S&H circuit is possible as well (bi-stable multivibrator) but also looses information after battery has been removed.

MW (4 Bit, 11:8) 14h
MW defines the number of the average calculation exponent for the temperature sensor. The average is calculated by 2^MW measurements. The result will be stored as averaged temperature value or will be used for comparison in Outband Mode

MonDataEnd (8 Bit, 7:0) 14h
MonDataEnd defines the end of the storage range for interrupt and sensor data. The addresses after MonDataEnd are empty. This free storage can not be used for user data (assignment to USER bank). MonDataEnd has a range from 1Ch - FFh. MonDataEnd will be set to FFh, when trying to set a value which is higher than the maximum valid value.

SPISense (1 Bit, 15) 14h
This bit defines if a external digital sensor is connected via SPI and external µC.
If the SPISense bit is not set, datamonitoring will go to Power Down Mode after all internal log cycles.

IntervalLength (8 Bit, 7:0) 15h
Measurement period in minutes. Before starting the monitor the period term will program the timer. If the period term is 0, the Datamonitor continously processes measurement data as fast as possible.

TimePreset (16 Bit, 31:16) 15h
Sets a wait time before the first measurement cycle will be started. Time calculates to TimePreset x 1min.

IntDataXH (12 Bit, 27:16) 16h
Upper limit value of external X sensor for interrupt mode.

IntDataXL (12 Bit, 12:0) 16h
Lower limit value of external X sensor for interrupt mode.

IntDataYH (12 Bit, 27:16) 17h
Upper limit value of external Y sensor for interrupt mode.

IntDataYL (12 Bit, 11:0) 17h
Lower limit value of external Y sensor for interrupt mode.

CoeffGainX (12 Bit, 27:16) 18h
Value for normalisation function of measurement correction to 8 bit for X-Port. Complement of 2.

CoeffOffsX (12 Bit, 11:0) 18h
Value for normalisation function of measurement correction to 8 bit for X-Port. Complement of 2.
NORMX(11:4) = MwData (11:0)*CoeffGainX + CoeffOffsX
MwData = Average(MWE) from measurement data of external sensor

CoeffGainY (12 Bit, 27:16) 19h
Value for normalisation function of measurement correction to 8 bit for Y-Port. Complement of 2.

CoeffOffsY (12 Bit, 11:0) 19h
Value for normalisation function of measurement correction to 8 bit for Y-Port. Complement of 2.
NORMY[11:4] = MwData[11:0]*CoeffGainY + CoeffOffsY
MwData = Average(MWE) from measurement data of external sensor

CPEN (X or Y) (1 Bit, X Bit 14, Y Bit 30) 1Ah
Enable signal for positive adjustable capacity in analog module for the external sensor to reduce the external static capacity of the sensor.

CP (X or Y) (6 Bit, X 13:8, Y 29:24) 1Ah
Value for positive adjustable capacity in analog module for external sensor to reduce the external static capacity of the sensor. Value has the equivalent capacity - intern/200 versus extern.

CNEN (X or Y) (1 Bit, X Bit 6, Y Bit 22) 1Ah
Enable signal for negative adjustable capacity in analog module for the external sensor to reduce the external static capacity of the sensor.

CN (X or Y) (6 Bit, X 5:0, Y 21:16) 1Ah
Value for negative adjustable capacity in analog module for external sensor to reduce the external static capacity of the sensor. Value has the equivalent capacity - intern/200 versus extern.

Calib_ConstY (12 Bit, 27:16) 1Bh
Value for calibration constant for external sensor.

Calib_ConstX (12 Bit, 11:0) 1Bh
Value for calibration constant for external sensor.

SENSEDATAMONITOR command interface

The commands CMD start and stop with its particular mode (for example Outband) and the RSP can be processed by a customer command (command A0h). It is possible with this command to start, stop and to influence the SenseDataMonitor.
This command will be written as a customer command instruction ICMfgDepend (A0h). The last 4 bits of the assigned bytes are reserved for the command and for parameters. The Sensedatamonitor is setting RSP after start completely to '1', is working according to the command and writing the result to RSP. The configuration is shown in the following tables.

CMD

Table 9 – CMD description

Reader HF CCI ICMfg	Command (bits 3..0)	Name	Parameter	Description
00	0000	cmdNOP	non	no operation
04, 05 (CAL) 06 (Outband)	0100	cmdSTART	Bit0: Calibration Mode Bit1: Outband Mode	start Monitor and erase MonIndicator use bounds
08	1000	cmdSTOP	non	Stop Sensedatamonitor

RSP

Table 10 – RSP description

Answer (bits 3..0)	Name	Parameter	Description
0000	rspNOP		No answer
0100	rspSTART	Bit0: Calibration Mode Bit1: Outband Mode	Monitor start use bounds
1000	rspSTOP	Bit0: Calibration Mode Bit1: Outband Mode	Monitor stop
1110	rspUSE	Bit0: Calibration Mode	Monitor is working

A start with Bit0=1 for calibration mode will calibrate the external sensors. For this mode it is possible to hold the external sensors in static state for defined calibration data. After this cycle the SENSEDATAMONITOR will automatically store the calibration data in the EEPROM and stop the monitoring feature with a power down.

Work of Sensedatamonitor

When starting the monitor the MonIndicator in MONREG will be reset. Statusflags in MONREG will update at start and stop. If the Sensedatamonitor is writing into the last measurement address the Sensedatamonitor will be stopped and the MonIndicator will be incremented.

The system is checking if a battery voltage is correct for a measurement before it starts with the temperature measurement. If battery voltage is low the Sensedatamonitor will stop and the battery error flag will be set. Dependent of the SPI Sense-Flag the monitor part will be set to Power Down Mode.

Definition:

- SPISense = ‚0'
  → At stop or too low battery voltage go in power down
- SPISense = ‚1' and SPI_PDN = ‚1'
  → At stop or too low battery voltage go in power down
- SPISense = ‚1' and SPI_PDN = ‚0'
  → At stop or too low battery voltage stay in wakeup

Note: With every successful write cycle via RFID (non blocked MONREG bank) in the area from 10h..19h the Datamonitor will be stopped and the MonIndicator will be set to zero.

Command structure for reader Software ICMfg A0h

The customer command instruction ICMfgDepend (A0h) is defined with a Byte to control the monitor function.

Sending structure

Table 11 – Sending structure

CMD	7	6	5	4	3	2	1	0
	rfu	01 Wakeup Ext dig. Sense		rfu	01 Start Monitor 10 Stop Monitor 00 No Operation 11 No Operation		OutBand Mode	Calibration Mode

Example SCEMTEC conform

```
6C1E 00 A0 20 04  -- Start Monitor in Normalmode
|    |  |  |  |-- Command (08=Stop,05=StartCalib.,06=Start Outband Mode)
|    |  |  |----- ICMfg from VICC UID
|    |  |-------- Custom command address static defined A0h
|    |----------- Request Flags
|---------------- Reader Command (SCEMTEC STX/ETX Protocol, OEM specific)
```

6C1E00A02008 – Stop Monitor; 0004 back, 0006 back (outband mode)
6C1E00A02005 – Start Calibration of external analog sensors; 000F back
6C1E00A02006 – Start Monitor in Outband Mode; 000E back
6C1E00A02020 – Wakeup for external digital process (Power battery on)

The answer of customer command is defined in the following table.

Responding structure

Table 12 – Responding structure

CMD	7	6	5	4	3	2	1	0
	“000”			Wakeup Ext dig. Sense	RSP information from Monitor (See Table 10)			

Example

```
6C1E 00 0E
|    |  |-- response data see Table 12 (rspUSE, no Calibration Mode)
 |    |----- response requested flags
|---------- Reader Command (SCEMTEC STX/ETX Protocol, OEM specific)
```

When starting the monitor the log counter will be reset. Additionally the status flags will be updated at start and stop of the monitor. After writing the last empty block the monitor will be stopped.

Before every new temperature measurement the system measures the battery voltage to ensure a complete measurement and storage cycle can be conducted. When the battery voltage is to low at this time the monitor will be stopped and the BATTERY ERROR FLAG will be set to ‘1’. This safety feature can be overridden by setting the BattChkOff register to ‘1’.

The data monitor will be stopped and the logstatus and logcounter will be reset after each successful write cycle (no locked MONREG bank) in the address space from 11h to 1Bh.

Note: PE GmbH delivers samples and production volume ICs in calibrated condition (RTC, TMS). The nature of the chip allows everybody to access AND change these values at any time as long as the MONREG bank is not locked. If the MONREG bank will be locked the data monitoring setup can not be changed any more. The values are trimmed in the test process during manufacturing and are guaranteed to be within specified limits.

9.3 MONDAT Bank

Blocks in the MONDAT bank can only be read through the RFID interface, independent of the lock information. Data monitor has always full access to these blocks.

Table 13 – MONDAT bank interrupt area

MONDAT Bank	Bit 31..24	Bit 23..16	Bit 15..8	Bit 7..0
1Ch .. 1Ch+IntDataArea-1	MonIndicator	IntervallTime	IntMeasDatY	IntMeasDatX

MonIndicator (8 Bit)
Numbers of counted monitor spaces. So it is possible to recalculate the starting time.

IntervallTime (8 Bit)
Time inside a monitor spacing in minutes to calculate the exact term.

IntMeasDatY (8 Bit)
Normalized value of maximum/minimum measured data on Y-Port during an interrupt. The maximum/minimum value will calculated during an interrupt phase. It does not matter wether the interrupt occured on X- and/or Y-port.

IntMeasDatX (8 Bit)
Normalized value of maximum/minimum measured data on X-Port during an interrupt. The maximum/minimum value will calculated during an interrupt phase. It does not matter wether the interrupt occured on X- and/or Y-port.

Table 14 – MONDAT bank monitor data

MONDAT Bank	Bit 31..24	Bit 23..16	Bit 15..8	Bit 7..0
1Ch+IntDataArea .. MonDataEnd	MonitorData			

MonitorData

The measurement data are in the area from Block 1Ch+IntDataArea to MonDataEnd. Combinations of the measurement results can be stored. This is depended on the mode. MonIndicator indicates how many valid values have been written into the EEPROM.

Table 15 – General measure data area

MONDAT Bank	Bit 31..24	Bit 23..16	Bit 15..8	Bit 7..0
1Ch+IntDataArea	Measure data			
…	Measure data			
MonDataEnd	Measure data			

Table 16 - Measure data for TempMODE = continuous, TM = 1, AX = 0, AY = 0 rsp. INT-Mode = 1

Measure data	Bit 31..24	Bit 23..16	Bit 15..8	Bit 7..0
	TempData measurement n+3	TempData measurement n+2	TempData measurement n+1	TempData measurement n

Table 17 - Measure data for TempMODE = continuous, TM = 1, AX = 1, AY = 0, INT-Mode = 0

Measure data	Bit 31..24	Bit 23..16	Bit 15..8	Bit 7..0
	XData measurement n+1	TempData measurement n+1	XData measurement n	TempData measurement n

Table 18 - Measure data for TempMODE = continuous, TM = 1, AX = 1, AY = 1, INT-Mode = 0

Measure data	Bit 31..24	Bit 23..16	Bit 15..8	Bit 7..0
	RFU	YData measurement n	XData measurement n	TempData measurement n

Table 19 - TM = 0, AX = 1, AY = 0, INT-Mode = 0

Measure data	Bit 31..24	Bit 23..16	Bit 15..8	Bit 7..0
	XData measurement n+3	XData measurement n+2	XData measurement n+1	XData measurement n

Table 20 - TM = 0, AX = 1, AY = 1, INT-Mode = 0

Measure data	Bit 31..24	Bit 23..16	Bit 15..8	Bit 7..0
	YData measurement n+1	XData measurement n+1	YData measurement n	XData measurement n

Table 21 - Measure data for TempMODE = outband, TM = 1, AX = 0, AY = 0, rsp. INT-Mode = 1

Measure data	Bit 31..24	Bit 23..16	Bit 15..8	Bit 7..0
	IntervalLength measurement n+1	TempData measurement n+1	IntervalLength measurement n	TempData measurement n

Table 22 - Measure data for TempMODE = outband, TM = 1, AX = 1 and/or AY = 1, INT-Mode = 0

Measure data	Bit 31..24	Bit 23..16	Bit 15..8	Bit 7..0
	YData measurement n	XData measurement n	IntervalLength measurement n	TempData measurement n

Note: Outband mode is only usable, when the internal temperature sensor is active.

IntervalLength
The IntervalLength for temperature measurement will not be stored in the EEPROM constantly but only if a Temp value will be stored. It counts the numbers of performed temperature measurements since the start of the Datamonitor in an 8-bit counter. The IntervalLength serves as a time base. Only relevant measurement results will be stored in the EEPROM.

Important: A value IntervalLength will sign on 15…8 bites in outband mode. If an IntervalLength over flow happens, then IntervalLength = 0 will be written into the EEPROM, even if the measured value is within the temperature limit. By means of the count of measurements with the IntervalLength = 0 all measuements results can be assigned clearly.

Power On Reset
At POR (battery on) the log counter and all status flags and the AlarmPort will be set to ’0’.

9.4 USER Bank

Available EEPROM memory is divided into MONDAT and USER. Size of MONDAT bank and USER bank is defined by parameter MonDataEnd in MONREG. Content of USER bank has to be defined by the user.

Table 23 – USER bank

USER Bank	Bit 15..12	Bit 11..8	Bit 7..4	Bit 3..0
MonDataEnd + 1 .. FFh	UserData			

9.5 Physical Memory Organization

Table 24 – Physical memory organization 1

UID-Bank				
Addr.	**Bit**	**Data**	**Mode**	**Description**
00h	**31-0**	**InfoFDV**	**Bit**	**Info of VICC, DSFID, Flags ISO15693 conform**
	31-24	InfoFlag	r/w	Info Flag
	23-16	DSFID	r/w	DSFID
	15-0	MSI	r/w	MSI
01h	**31-0**	**AFIFLAGS**	**Bit**	**AFI Flags of VICC ISO15693 conform**
	31-24	RFU		
	23-16	ICRef	r/w	IC Reference
	16-8	T1OV	r/w	T1 Overhead
	7-0	AFI	r/w	AFI
02h	**31-0**	**UID [63:32]**	**r/w**	**UID ISO15693 conform**
03h	**31-0**	**UID [31:0]**	**r/w**	**UID ISO15693 conform**
04h	**31-0**	**LOCK[31:0]**	**r/w**	**Lock Data for VICC ISO15693 conform**
05h	**31-0**	**LOCK[63:32]**	**r/w**	
06h	**31-0**	**LOCK[95:64]**	**r/w**	
07h	**31-0**	**LOCK[127:96]**	**r/w**	
08h	**31-0**	**LOCK[159:128]**	**r/w**	
09h	**31-0**	**LOCK[191:160]**	**r/w**	
0Ah	**31-0**	**LOCK[223:192]**	**r/w**	
0Bh	**31-0**	**LOCK[255:124]**	**r/w**	
0Ch-0Dh	**31-0**	**RFU**		
0Eh	**31-0**	**TempScaling**		**Temperature Scaling for Software**
	31-16	RFU		
	15-8	Slope		Slope for TempScaling
	7-0	Offset		Offset for TempScaling
0Fh	**31-0**	**MonCycle**	**r**	**Operation cycle counter (total number of measurement intervals, never erased)**

Table 25 – Physical memory organization 2

MONREG-Bank				
Addr.	**Bit**	**Data**	**Mode**	**Description**
10h	**31-0**	**LogCount**	**Bit**	**Intcnt,Statusflags, Monitor counter, automatic erased on write from addr. 11h to 1Bh**
	31-24	RFU		
	23-16	IntAddrCnt	r	Number of written Interrupt addresses
	15	Start	r	Flag Initializing, Monitor started, 0b = not started 1b = started
	14	Active	r	Flag Monitoring is active, 0b = not activted 1b = activated
	13	Overflow	r	Flag Memory overflow, 0b = no overflow 1b = overflow detected
	12	WDTError	r	Flag Watchdog error, 0b = Watchdog ok 1b = Watchdog overflow detected
	11	BatteryError	r	Flag Battery error, 0b = Battery ok 1b = Battery capacity error
	10	Alarm	r	Flag Alarm port enabled, 0b = no Alarm 1b = Alarm counter overflow detected
	9	Outband	r	Flag Outband mode activated, 0b = normal mode 1b = outband mode
	8	IntExt	r	Interrup external sensor triggered
	7-0	MonIndicator	r	Measurement counter for written data into EEPROM
11h	**31-0**	**ExtSenseFlags**	**Bit**	**Flags for external and internal configuration**
	31-28	RFU		
	27-24	CLK1TRIM	r/w	Value to trim 1 MHz Oscillator for external ADC clock
	23-16	IntSample	r/w	Timing definition to sample interrupt data intervall (10ms typical)
	15-10	RFU		
	9	DEY	r/w	Differential enable - Y 1b = single ended 0b = differential
	8	DEX	r/w	Differential enable - X 1b = single ended 0b = differential
	7	RFU		
	6-4	MWE	r/w	average (2^MWE) of external sensor
	3	IM	r/w	Interrupt Mode for external sensors, 1b = active 0b = deactive
	2	AY	r/w	Connection Flag Y-Port of external sensor
	1	AX	r/w	Connection Flag X-Port of external sensor
	0	TM	r/w	Temperature measurement enable, 1b = active 0b = deactive

Addr.	Bit	Data	Mode	Description
12h	**31-0**	**Temp, RTC**	**Bit**	**Temperature limit and RTC trim**
	31-24	TempLimHi	r/w	Constraint of high measured value
	24-16	TempLimLo	r/w	Constraint of low measured value
	15-8	RTCFreq	r/w	RTC trimming frequency
	7-0	RTCTemp	r/w	RTC trimming temperature
13h	**31-0**	**TMS**	**Bit**	**Trimming value for TMS**
	31-30	RFU		
	29	BattChk	r/w	Battery Check Ok definition, 0b = Check Battery 1b = dont check battery
	28	Sign	r/w	Algebraic sign (pos/neg) of the offset counter, 0b = neg 1b = pos

Table 26 – Physical memory organization 3

MONREG-Bank				
Addr.	**Bit**	**Data**	**Mode**	**Description**
13h	27-16	TempOffs	r/w	Offset counter for temperature measurements
	15-8	OSC2	r/w	Trimming value for Osc1
	7-0	OSC1	r/w	Trimming value for Osc1
14h	**31-0**	**Area**	**Bit**	**Area definitions for Measurement**
	31-24	IntDataArea	r/w	Number of Interrupt addressesfor external sensors
	23-16	AlarmNbr	r/w	Value to set Alarm Port to VSS if LogCout greater AlarmLogCnt
	15	SPISense	r/w	select SPI Interface, 0b = Power Down possible 1b = no Power Down Mode
	14-12	RFU		
	11-8	MW	r/w	Mean value to calculate measured data (2^MW)
	7-0	MonDataEnd	r/w	Size of memory to store measured data
15h	**31-0**	**TimeDef**	**Bit**	**Timing definitions for Monitoring**
	31-16	TimePreset	r/w	Time preset, Wait time before monitoring starts
	15-8	RFU		
	7-0	IntLength	r/w	Intervall Length, duration of a measurement intervall
16h	**31-0**	**IntDataX**	**Bit**	**Limit values of external X sensor for interrupt mode**
	31-28	RFU		
	27-16	IntDataXH	r/w	Upper limit value of external X sensor for interrupt mode
	15_12	RFU		
	11-0	IntDataXL	r/w	Lower limit value of external X sensor for interrupt mode
17h	**31-0**	**IntDataY**	**Bit**	**Limit values of external Y sensor for interrupt mode**
	31-28	RFU		
	27-16	IntDataYH	r/w	Upper limit value of external Y sensor for interrupt mode
	15_12	RFU		
	11-0	IntDataYL	r/w	Lower limit value of external Y sensor for interrupt mode

Addr.	Bit	Data	Mode	Description
18h	**31-0**	**CoeffNormX**	**Bit**	**Normalisation function of measurement correction to 8 bit for X-Port**
	31-28	RFU		
	27-16	CoeffGainX	r/w	Value for normalisation function of measurement
	15-12	RFU		
	11-0	CoeffOffsX	r/w	Value for normalisation function of measurement
19h	**31-0**	**CoeffNormY**	**Bit**	**Normalisation function of measurement correction to 8 bit for Y-Port**
	31-28	RFU		
	27-16	CoeffGainY	r/w	Value for normalisation function of measurement
	15-12	RFU		
	11-0	CoeffOffsY	r/w	Value for normalisation function of measurement

Table 27 – Physical memory organization 4

MONREG-Bank				
Addr.	**Bit**	**Data**	**Mode**	**Description**
1Ah	**31-0**	**CPCN**	**Bit**	**Adjustable capacity values**
	31	RFU		
	30	CPENY	r/w	Enable signal for negative adjustable capacity Y high active
	29-24	CPY	r/w	Negative value for adjustable capacity Y
	23	RFU		
	22	CNENY	r/w	Enable signal for positive adjustable capacity Y high active
	21-16	CNY	r/w	Positive value for adjustable capacity Y
	15	RFU		
	14	CPENX	r/w	Enable signal for positive adjustable capacity X high active
	13-8	CPX	r/w	Positive value for adjustable capacity X
	7	RFU		
	6	CNENX	r/w	Enable signal for negative adjustable capacity X high active
	5-0	CNX		Negative value for adjustable capacity X
1Bh	**31-0**	**CalibConst**	**Bit**	**Calibration constant to external sensor**
	31-28	RFU		
	27-16	Calib_ConstY	r/w	Value for calibration constant to external sensor Y
	15-12	RFU		
	11-0	Calib_ConstX	r/w	Value for calibration constant to external sensor X

Table 28 – Physical memory organization 5

MONDAT-Bank				
EEPROM Addr.	**Bit**	**Data**	**Mode**	**Description**
1Ch	**31-0**	**IntDatExtSense**	**r**	**Interrupt measure data from extern sensor**
	31-24	MonIndicator	r	Numbers of counted monitor spaces
	23-16	IntervallTime	r	Time inside a monitor spacing in minutes
	15-8	IntMeasDatY	r	Normalized value of maximum/minimum measured data on Y-Port
	7-0	IntMeasDatX	r	Normalized value of maximum/minimum measured data on X-Port
…	**31-0**	**IntDatExtSense**	**r**	**…**
1Ch+ IntDataArea-1	**31-0**	**IntDatExtSense**	**r**	**Interrupt measure data from extern sensor**
1Ch+ IntDataArea	**31-0**	**MonitorData**	**r**	**Log data of measurements and timing information mode different**
…	**31-0**	**…**	**r**	**…**
MonDataEnd	**31-0**	**MonitorData**	**r**	**Log data of measurements and timing information mode different**

Table 29 – Physical memory organization 6

USER-Bank				
EEPROM Addr.	**Bit**	**Data**	**Mode**	**Description**
MonDataEnd+1	**31-0**	**UserDat**	**r/w**	**User data defined from user**
…	**31-0**	**UserDat**	**r/w**	**…**
FFh	**31-0**	**UserDat**	**r/w**	**User data defined from user**

10 Sensor monitor Functions

It is possible to use many sensor driven functions with the PE3011. The PE3011 can be used with a single or multiple sensors or with the integrated temperature sensor only.

The main sensor function is a temperature measurement of the chip temperature.

Another sensor driven function is using the external capacitive sensor interface to sense capacitive sensors from 1pF till 10pF. The nature of these capacitive sensors does not matter. It can be an accelleration MEMS, a moisture sensor or others. Linearization is not conducted on the chip.

To complete the sensor functionality it is also possible to connect digital interfaced sensors through a microcontroller over the SPI interface to the PE3011. The SPI interface interaction is described in chapter 11.

10.1 Temperature sensor

The internal temperature data monitoring block measures the chip temperature by user defined processing and safes timing defined temperature data in the EEPROM. To control a user defined temperature measurement with timing information all necessary data will be read from the EEPROM during the initialisation phase. It is necessary to activate the TM Flag in EEPROM at address 11h to use the temperature monitor function.

The temperature measurement has a continuous mode or an outband mode function that can be activated by a start command (see Table 9)

Continuous mode – sense after start up time (TimePreset) at every time interval (IntLength) the chip temperature and stores the measured data in EEPROM.

Outband mode – sense after start up time (TimePreset) at every time interval (IntLength) the chip temperature and stores the measured data and timing information in EEPROM, if the measured data are outside the defined limits (TempLimit).

10.2 Capacitive sensor interface

For several differential or single ended capacitive sensor signals (direct sensor output) an analog capacitive sensor interface is implemented in the PE3011. It can be programmed for assembly levels, speed, accuracy, normalisation (CoeffGain, CoeffOffset) and interrupt levels (Interrupt Sample time, Interrupt level) via EEPROM addresses. The normalisation converts the sensor signal to an 8-bit result.

A differential capacitive variation is defined from 1pF to 10pF. For maximal usability it is possible to select a non differential mode between CX1 and CXM or CY1 and CYM (DEX, DEY on address 11h).

To use the external sensor interface it is possible to activate the AY and/or AX Flag on address 11h. If only one external sensor is used it is necessary to use the X sensor interface.

The monitoring structure allows for continuous measurements on defined time points (as for temperature sampling) or for an interrupt based (user defined high or low interrupt levels) measurement (IM Flag on address 11h).

Continuous handling – sense after start up time (TimePreset) at every time interval (IntLength) the results and write measured data to EEPROM.

Interrupt handling – an interrupt will be capturing the maximal measured signal after start up time. After the interrupt handling procedure (IntSample in ms at address 11h) the next interrupt can be stored. Several interupts can be stored during measurements. The amount is defined in the EEPROM (IntDataArea). Further interrupts will be ignored. Interrupt data addresses are defined at 1Ch till 1Ch+IntDataArea (see Table 13). If one of these addresses is written, an interrupt flag will be set (IntExt address 10h).

Calibration mode – it is possible to calibrate the external sensors with a command. A “start” in calibration mode will calibrate the external sensors. For this mode it is possible to hold the external sensors in static state (MEMS) for defined calibration data. After this cycle the PE3011 will automatically store the calibration data in the EEPROM at address 1Bh and stop the monitoring cycle with power down.

10.3 Measured data structure for applied sensors

The data structure for measured results is dependend on sensor and mode. Chapter 9.3

Table 14 (following) describes the EEPROM data structure.

11 Serial Interface

The EEPROM can be accessed through a standard serial interface with SPI protocol. External sensor data can be stored in the internal EEPROM this way and can so be read through the RFID field. Clock frequency for this interface is limited to 1MHz. Transmission of address and data is executed with MSB first. When the data word is shorter than 16 bit the leading bits will have to be filled with '0'.

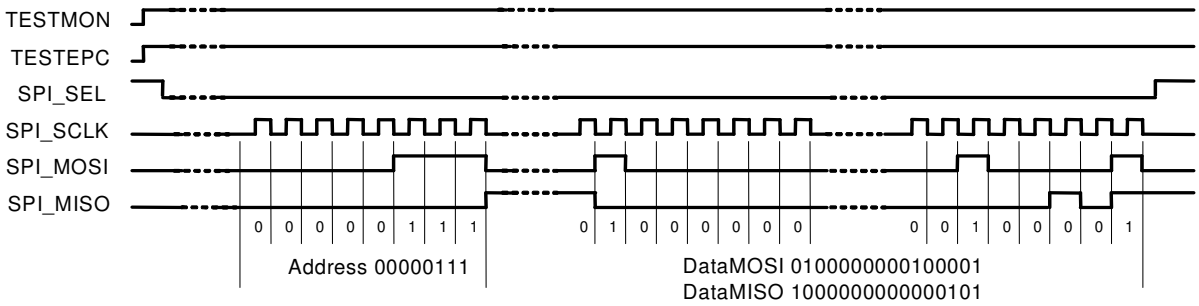

Figure 5 – SPI Interface

TESTMON / TESTEPC	Activate Test Mode (pull down input)
SPI_SEL	Activate SPI Transfer (low active, pull down input)
SPI_SCLK	SPI-Clock (pull down input)
SPI_MOSI	Serial Data Input (pull down input)
SPI_MISO	Serial Data Output

All input pins of the interface have pull down resistors. If no idle current into the pins is wanted, the pins must be set to high z or tied to ground. In this case the chip is in the normal operating state and the interface is not active.
The interface will be activated by setting the test signals "TESTMON" and "TESTEPC" to high (both lines can be shorted). At this time the internal state machine is halted.
The SPI_SEL is low active, as in most SPI standards, and defines the begin and the end of an data transfer (frame: address8, data16).
The data input (MOSI) will be latched with the rising clock edge into the chip. The data output (MISO) can be read by a µC during the clock line is high.

It is important to have a low clock line when SPI_SEL is switched to low – otherwise a rising clock pulse will be generated at this transition.

11.1 SPI Addresses

For programming and reading of the EEPROM certain command sequences will have to be obeyed. Follow the sequences described in the tables below. At the beginning an initializing has to be executed. Afterwards addresses can be accessed.

Before a memory cell can be written to an 'ERASE' has to be conducted. The wait time between 'ERASE' and 'WRITE' has to be at least 4ms.

Table 30 – Serial interface – initializing

Address	Data	Command
0x06	0x8000	Set Wakeup
0x06	0x0000	Clear Wakeup
0x20	0x0018	Set Sleep, Reset
0x01	0x0000	Clear EEPROM CTRL
0x02	0x0000	Clear EEPROM Address
0x03	0x0000	Clear EEPROM DATA

Table 31 – Serial interface – disable

Address	Data	Command
0x20	0x0018	Set Sleep, Reset
0x06	0x4000	Set Powerdown
0x06	0x0000	Clear Powerdown

Table 32 – Serial interface – write EEPROM

Address	Data	Command
0x01	0x00C0	Set Mem, Set EEPROM
0x02	address	Set Address
0x03	data	Set Data
0x01	0x00C8	Set Erase
		wait for 4ms
0x01	0x00C0	Clear Erase
0x01	0x00C2	Set Write
		wait for 4ms
0x01	0x00C0	Clear Write

Table 33 – Serial interface – read EEPROM

Address	Data	Command
0x01	0x00C0	Set Mem, Set EEPROM
0x02	address	Set Address
0x01	0x00C1	Set Read
0x03	0x0000	Read Data the memory data will be received at the MISO pin
0x01	0x00C0	Clear Read

11.2 SPI EEPROM organisation

Generaly the EEPROM is organised as 8 bit addressable 32 bit data memory. All SPI data transfers are specified with 16 bit datatransfer. To read or write the EEPROM with full data it is necessary to define a SPI procedure with new address range (8:0 vs. 7:0). The transferable data of 32 bit are splitted in high 16 bit and low 16 bit and the address will added by 1 bit for highest 16 bit (‘1’) and lowest 16 bit (‘0’).

Example:

Write 32 bit to EEPROM:	ADDR 0x0003 DATA 0xE017132A
is splitted to write SPI:	ADDR 0x0003 DATA 0x123A
	ADDR 0x0103 DATA 0xE017
Read 32 bit from EEPROM:	ADDR 0x0004 DATA 0x 4002499E
is splitted to read SPI:	ADDR 0x0004 DATA 0x0000 Back → 0x499E
	ADDR 0x0104 DATA 0x0000 Back → 0x4002

12 List of abbreviations

µC	Microcontroller
ADC	Analog to digital converter
ADDR	Address
AFI	Application family identifier
AFIFLAGS	Flags for AFI
AlarmNbr	Alarm number data
AX	Flag to use X-sensor
AY	Flag to use Y-Sensor
BattChk	Battery chek flag
BattChkOff	Battery check flag off
Calib_ConstX	Calibration constant for X-sensor
Calib_ConstY	Calibration constant for Y-sensor
CalibConst	Calibration constant
CLK1MTRIM	Trimmdata for 1MHz clock
CLKFTrim	Trimmdata for frequency of 8kHz clock
CLKTTrim	Trimmdata for temperature of 8kHz clock
CMD	Command
cmdNOP	Command no operation
cmdSTART	Command start
cmdSTOP	Command stop
CNENX	Enable negative capacity on X-sensor
CNENY	Enable negative capacity on Y-sensor
CNX	Data of negative capacity for X-sensor
CNY	Data of negative capacity for Y-sensor
CoeffGainX	Gain coefficient for X-sensor
CoeffGainY	Gain coefficient for Y-sensor
CoeffNormX	Normalisation coefficient on X-sensor
CoeffNormY	Normalisation coefficient on Y-sensor
CoeffOffsX	Offset coefficient for X-sensor
CoeffOffsY	Offset coefficient for Y-sensor
CPCN	positiv capacity negativ capacity register
CPENX	Enable positve capacity on X-sensor
CPENY	Enable positve capacity on Y-sensor
CPX	Data of positve capacity for X-sensor
CPY	Data of positve capacity for Y-sensor
CDC	Capacitive digital converter
CX1	Capacity on X1 port
CXM	Capacity on middle port of X
CY1	Capacity on Y1 port
CYM	Capacity on middle port of Y
DEX	Differential enable for X-sensor
DEY	Differential enable for Y-sensor
DIFF_ENX	Differential enable for X-sensor
DIFF_ENY	Differential enable for Y-sensor
DSFID	Data storage format identifier
EEPROM	Electrical eraseable programmable read only memory
ERASE	Erase function
FFh	Last address of EEPROM
FLAGS	Register to set functions in hardware
HF	High frequency
IC MFG	IC manufacturer code ISO15693 conform
ICMfgDepend	IC manufacturer code depend ISO15693 conform
ICREF	IC reference ISO15693 conform
ICRef	IC reference ISO15693 conform
ID	Identifier
IM	Interrupt mode
InfoFDV	Information flag ISO15693 conform
InfoFlag	Information flag ISO15693 conform
IntAddrCnt	Interrupt address counter register
IntDataArea	Interrupt data area register
IntDataXH	Interrupt data X-sensor high limit
IntDataXL	Interrupt data X-sensor low limit
IntDataYH	Interrupt data Y-sensor high limit
IntDataYL	Interrupt data Y-sensor low limit
IntDatExtSense	Interrupt data external sensor
IntExt	Interrupt data external sensor
IntLength	Integer length
IntMeasDatX	Interrupt measure data X-sensor 12Bit
IntMeasDatY	Interrupt measure data Y-sensor 12Bit
INT-Mode	Interrupt mode
IntSample	Interrupt sample
ISO	International Standardization Organization
LOCK	Lock register of RFID-tag
MEMS	Microelectromechanical systems
MonCycle	Monitoring cycle
MONDAT	Monitoring data bank
MonDataEnd	Monitoring data end address
MonIndicator	Monitoring indicator
MonitorData	Monitoring data
MONREG	Monitoring register bank
MSI	Memory size information
MWE	Mathematical average
NOM	Nominal
OSC1	Oscillator 1 temperature indifferent
OSC2	Oscillator 2 temperature different
POR	Power on reset
RF	Radio frequency
RFID	Radio frequency identification
RFU	Resefed for future use
RSP	Response
rspNOP	Response noo operation
rspSTART	Response start
rspSTOP	Response stop
rspUSE	Response in use
RTC	Radio timing clock
RTCFreq	Radio timing clock frequency register
RTCTemp	Radio timing clock temperature register
RTCTrim	Radio timing clock trimm register
Sign	Sign (positive = ‚0' negative = ‚1')
Slope	Slope
SPI	Sereal programmable interface
SPI_MISO	SPI master in slave out
SPI_MOSI	SPI master out slave in
SPI_SCLK	SPI system clock
SPI_SEL	SPI select
T10V	T1 overhead
T10VH	T1 overhead high
T_{amb}	Ambience temperature
TempData	Temperature data
TempLimHi	Temperature limit hight data
TempLimit	Temperature limit
TempLimLo	Temperature limit low data
TempMODE	Temperature mode
TempOffs	Temperature offset
TempScaling	Temperature scaling
TimePreset	Temperature preset
TM	Temperature mode flag
TMS	Temperature monitoring system
TMSTrimOffs	TMS trimming offset data
TMSTrimOSC	TMS trimming oscillator data
TSSOP	Thin shrink small outline package
UID	Unique identifier
UserDat	User data bank
VICC	Vicinity integrated circuit card
VICCMSInfo	VICC most significant info
WDTError	Watchdog timer error
XData	X-sensor data
YData	Y-sensor data

13 Contact

Germany

Stuttgart
Productivity Engineering
Process Integration GmbH
Behringstrasse 7
D-71083 Herrenberg
Germany
Phone.: +49 (0) 70322798 0
Fax: +49 (0) 70322798 29
Email: info@pe-gmbh.com
Web: www.pe-gmbh.com

Dresden
Productivity Engineering GmbH
Branch
Sachsenallee 9
D-01723 Kesselsdorf
Germany
Phone.: +49 (0) 35204777 00
Fax: +49 (0) 35204777 000
Email: info@pe-gmbh.com